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SOME ABIOTIC FACTORS AFFECTING SEASONAL CHANGES IN SOIL ARTHROPOD POPULATIONS IN A PINE ECOSYSTEM

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ABSTRACT

The total arthropods ranged from 208×10^2 to 1600×10^2 m^{-2}. The Collembola being represented by *Isotoma trispinata* (Isotomidae) were dominant among the arthropods and represented by density of 1312×10^2 m^{-2}. The Acarina ranged from 84×10^2 to 416×10^2 m^{-2}. Other arthropod groups such as Protura, Diplura, Diplopoda, Chilopoda, Symphyla, Pauropoda, Formicidae, Isopoda, Coleopteran adults and larvae, Dipteran larvae, Thysanoptera, Hemiptera, Calanoids and Araneidae represented too few in number to show any seasonal change. The seasonal variation in the abiotic factors such as moisture content, temperatures at the soil surface and at 5 cm depth. pH and conductivity. P_2O_5, K_2O Fe_2O_3 and organic carbcn were cerrelated with various major taxa of the arthropods. and the reiationships are discussed.

Keywords : Pine ecosystem, soil arthropods, seasonal abundance,

INTRODUCTION

In India, although investigations on population ecology of soil and litter in habiting arthropods of different ecosystems are many (Reddy 1981; 1984), a detailed information on the edaphic arthropod populations in relation to various abiotic factors of pine ecosystems is meagre. This paper attempts to report seasonal fluctuations in the population density of some arthropods in a pine ecosystem of North - Eastern India in relation to different abiotic factors.

MATERIAL AND METHODS

STUDY AREA

The study area comprised of about half an acre, was located in a pine plantation habitat (*Pinus kesiya*) of Govt. of Meghalaya near Shillong, India. Its altitude is 1250m MSL. The The soil is acidic, and of reddish brown colour. (Reddy 1981). The work was carried out while the authors were at Shillong India.

SAMPLING AND EXTRACTION

Ten random soil samples were collected monthly betwcen September 1976 and April 1978 by an iron soil-sampler (5 X 5 X 10cm) from a pine Plantation seeded in 1965. All samples taken between 0800-1000 hrs were transferred to polythene bags, tied firmly and labelled. The extraction of arthropds followed within six hours of collection in laboratory for five days through a set of Berless-Tullgren funnels. Number of each species of arthropods thus extracted is recorded.

ABIOTIC FACTORS

Soil temperature was measured at the soil surface as well as at 5cm depth by a mercury thermometer from each collection spot. For physico–chemical analysis, samples were randomly mixed, air dried and passed through 2 mm sieve. Moisture content was measured gravimetrically by the oven-drying method. pH and specific conductivity were measured by a pH meter (Toshniwal Cat No. CL-43) and a Elico conductivity Bridge (Elico type CM-82) respectively. Organic carbon was estimated by the method described in Walkey and Blacks (1934). Available phosphorus (P_2O_5) and potassium (K^2O_5) and total iron (Fe_2O_3) were analysed after Piper (1966).

RESULTS

ABUNDANCE AND SEASONAL CHANGES IN ARTHROPOD POPULATIONS

The quantitative composition showed that Collembola was dominant (58.4%) among other soil arthropods such as Acarina, Protura, Diplura, Chilopoda, Symphyla, Diplopoda, Formicidae, Coleopteran adults and larvae, Calanoids and Dipteran larvae. (Fig-1) Collembola was represented by Isotomidae comprising 49.2%, Entomobryidae comprising 4.1%, Onychiuridae comprising 1.9%, Sminthuridae comprising 2.5%, and Hypogastruridae comprising 0.3% of the total arthropods. Acarina was represented by Prostigmata constituting

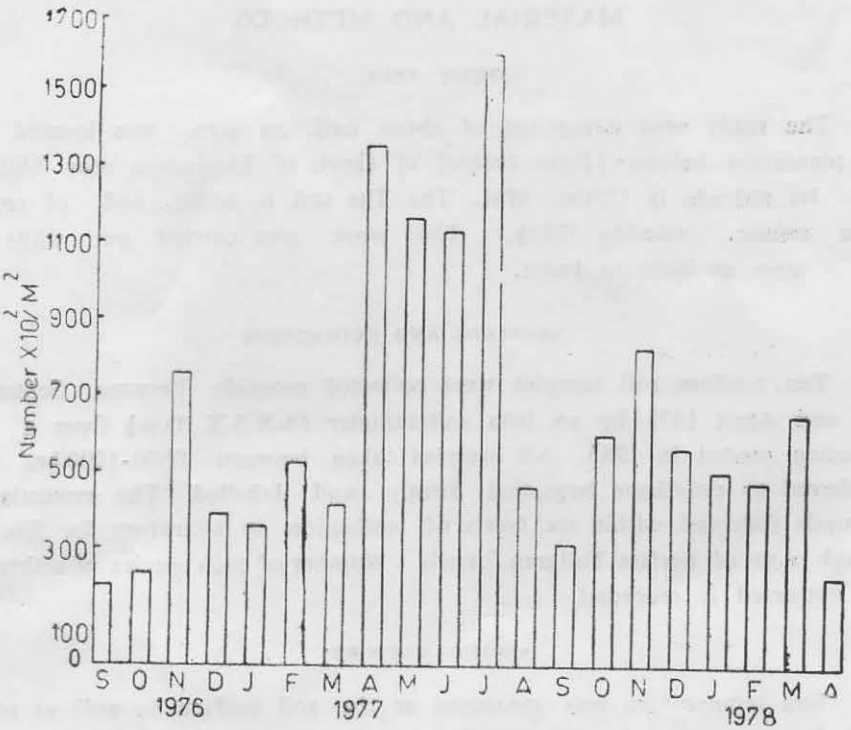

Fig. 1. Seasonal fluctuation in number of total edaphic arthropods during the study period.

16.5%, Mesostigmata constituting of 3.4% and Cryptostigmata constituting 11.1% of the total arthropods. *Isotoma* (Desoria) *trispinata* MacGillivray was dominant among the Collembola. Myriapoda represented by Diplopoda, Chilopoda, Symphyla and Pauropoda constituted 1.6% of the total arthropod populations. The groups such as Formicidae constituted 1.2% and Isopoda, Coleopteran adults and larvae, Thysanoptera, Hemiptera, Calanoids, Araneida and Dipteran larvae, each constituted less than 1% of the total arthropods.

The seasonal abundance of the total edaphic arthropods ranged from 208 to 1600 X 10^2 m^2 The Collembolan abundance was maximum in July 1977 (1312 X 10^2 m^2) and minimum in September (24 X $10^2 m^2$) (Fig. 2). However, during the second year the Collembola population was at maximum in October 1977 and minimum in Aprill 1978. Isotomidae was recorded minimum in number in September 1976 and suddenly increased in April 1977 reaching a small peak of 1052 X 10^2 m^2 and then reached the largest peak of abundance in July representing 1260 X 10^2 m^2. Entomobryidae and Sminthuridae did not show any significant seasonal variation (Fig 2), the former however being

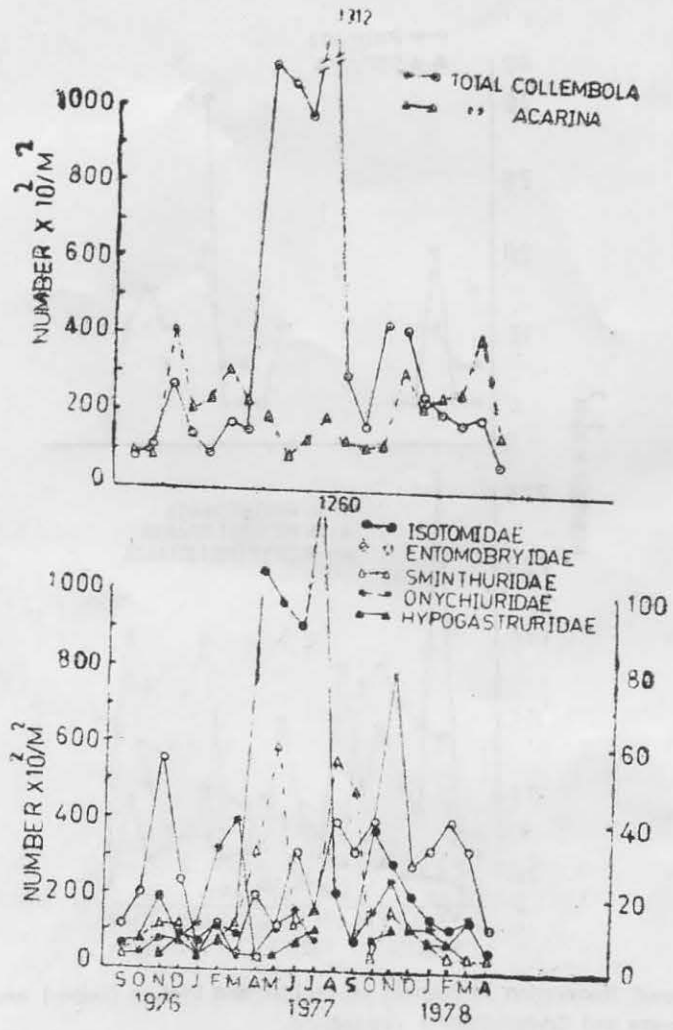

Fig. 2. Seasonal fluctuation in number of total Collembola and Acarina (Upper); and Isotomidae, Entomobryidae, Onychiuridae and Hypogastruridae (Lower) during the study period.

recorded minimum during January and March 1977 and maximum in November representing 80 X $10^2 m^2$ and the latter being recorded in peak of abundance in May representing 60 X $10^2 m^2$ and minimum during September 1976 and January 1977. Similarly Onychiuridae and Hypogastruridae were too few in number to detect any change in their seasonal abundance (Fig. 2).

The Protura was recorded maximum in November representing 36 X $10^2 m^2$ and minimum during September and October 1977 and April

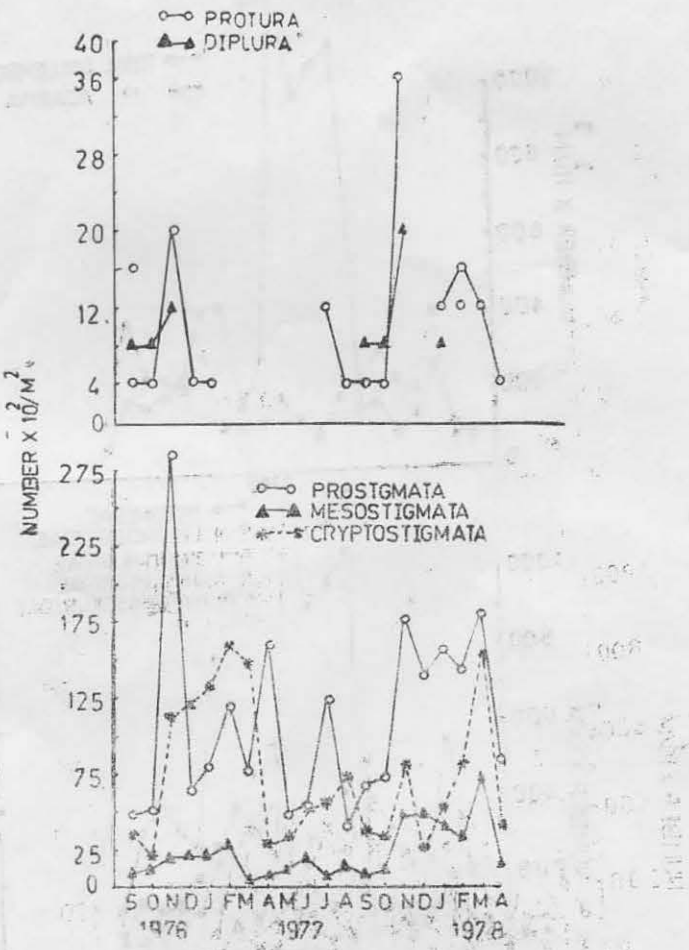

Fig. 3. Seasonal fluctuation in number of Protura and Diplura (Upper) and prostigmata, Mesostigmata and Cryptostigmata (Lower).

1978 and the Diplura were recorded maximum in March 1978, representing 16 X 10^2 m^2 (Fig.3). The abundance of total Acarina ranged from 84 X 10^2 m^2 to 416 X 10^2 m^2, the minimum being recorded in October 1976 followed by a sudden increase in November 1976 reaching the maximum (Fig. 2). Prostigmata reached the maximum in November 1976 representing 284 X 10^2 m^2 and minimum in August 1977 representing 40 X 10^2 m^2 (Fig 3). Cryptostigmata were recorded minimum in October 1976 representing 20 X 10^2 m^2 and reached maximum, 132 X 10^2 m^2 in February 1977. Mesostigmatid mites were too few to reflect any significant change in their seasonal abundance (Fig 3).

The abundance of Pauropoda, Chilopoda, Symphyla, Diplopoda, Isopoda, Thysanoptera, Hemiptera, Collopteran adults and larvae, Dipter[a] larvae, Hymenoptera, Calanoid and Araneidae hardly showed any distinc[t] seasonality.

SEASONAL VARIATION IN ABIOTIC FACTORS

The percentage of moisture content of the of the soil ranged from 12 to 44. 7% the maximum being recorded during October 1976 and the

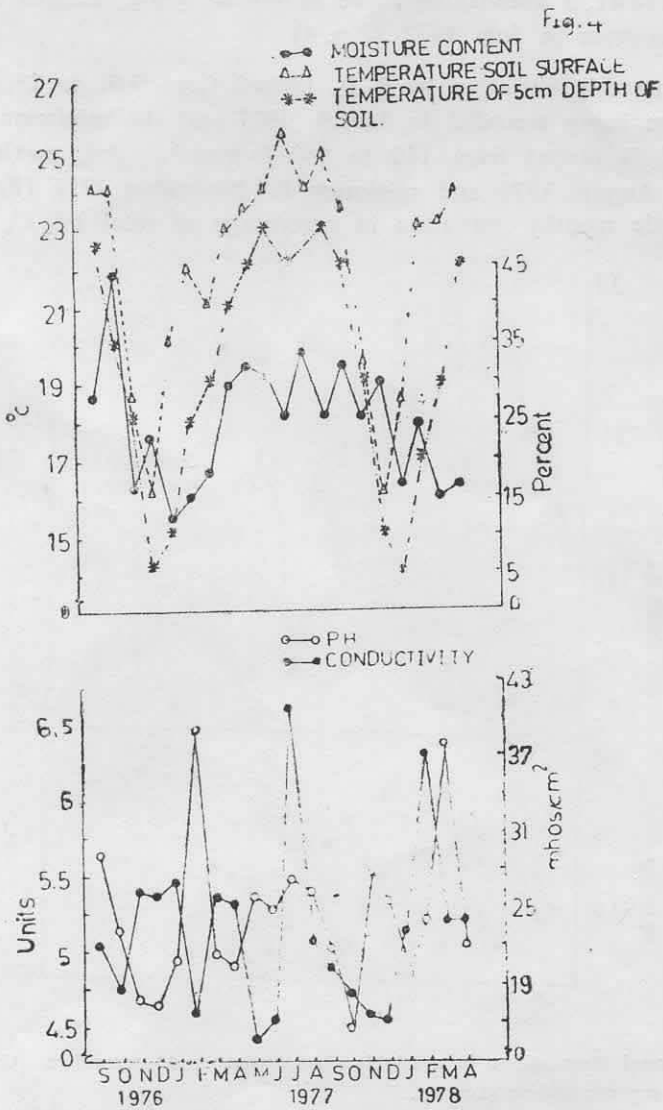

Fig. 4. Seasonal fluctuations in moisture content, temperature at soil surface and temperature at 5cm depth of the soil (Upper), and pH and conductivity (Lower) of the soil during the study period.

minimum during January 1977. The seasonal variation in the temperature at the soil surface and at 5 cm depth in the soil varied from 16.0 to 25. 5°C and 14.0 to 24.0°C respectively (Fig.4). The pH of the soil was acidic ranging from 4. 47 to 6. 67 and the maximum was recorded in February 1977 and the minimum in October 1976. The specific conductivity ranged from 14. 88 to 41. 3 umhos/cm^2, the minimum being recorded in May 1977 and the maximum in July 1977 (Fig. 4)

The monthly variation in $P_2 0_5$ ranged from 3.6 to 29. 6 lb acre-1 the maximum being recorded in March 1977 and the minimum in February 1978 and $K_2 O$ ranged from 140 to 650 lb acre-^{1}, the maximum being recorded in August 1977 and minimum in November 1977 (Fig. 5). There was very little monthy variation in percentage of total $Fe_2 O_3$ content as

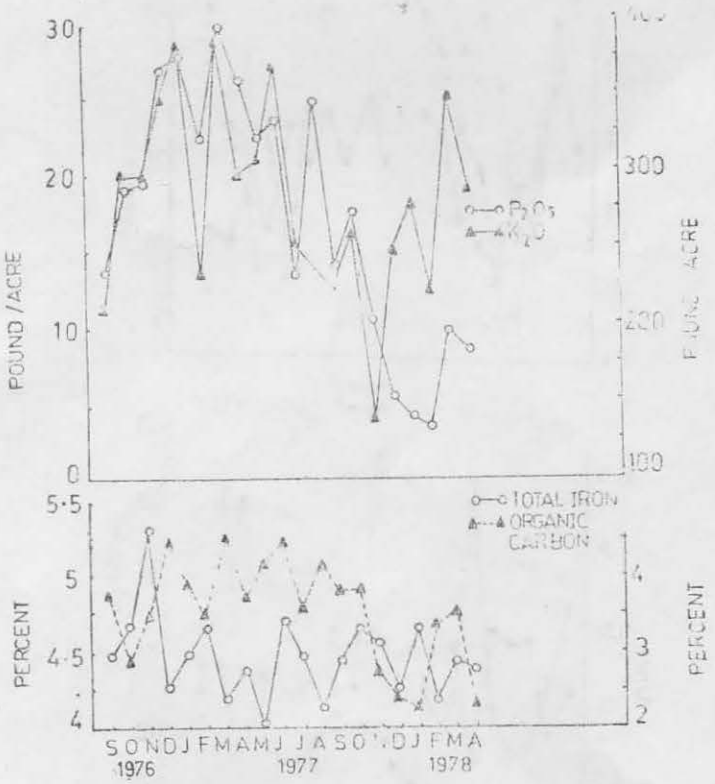

Fig. 5. Seasonal fluctuations in available phosphorus and potassium (Upper) and total iron and organic carbon (Lower).

it ranged from 4. 06 to 5. 43% the maximum being recorded in November 1976 and minimum in May 1977 (Fig.5). The percentage of organic carbon

ranged from 2.25 to 4.53 %, the maximum being recorded in March 1977 and minimum in January 1978.

DISCUSSION

Although the seasonal fluctuation in arthropod populations did not show any regularity in peaks of abundance (Fig. 1) it showed a significant correlation with the rainfall ($r = 0.46$; $P < 0.05$). In consistence Usher (1971) reported that the populations of soil arthropods were affected mainly by temperature and precipitation. Besides, the abundance of Collembola as recorded during the present study, is in consistence with the findings of Tragardh (1929) — 1200 X 10^2 m^2 and Price (1973) – 1461 X 10^2 m^2. The population fluctuation of Isotomidae, particularly *I. trispinata* followed the same pattern as that of the total Collembola. Ogino *et al* (1965) reported an increase in Collembola from August to March with an abrupt rise in May while Takeda (1973) recorded two peaks, one in December and the other in March. The maximum Collembola occurring during rainy months showed a significant positive correlation ($r = 0.59$; $P < 0.01$) with rainfall. Among the other physico-chemical factors the pH was positively significantly related to total Collembola ($r = 087$; $P < 001$). The pH being acidic may have a profound effect on the fecundity and longevity of the Collembola (Hutson 1978). Isotomidae the dominant taxa also has the same correlations as that of the total Collembola (with rainfall - $r = 0.58$; $P < 0.01$ and with pH-$r = 0.56$; $P < 0.01$).

The abundance of the total Acarina was less than the density estimates i.e., 793 X 10^3 m^2 recorded in a temperate pine forest (Persson *et a* 1980), and 274 X 10^2 m^2 in a coniferous site (Huhta and Koskenniemi 1975). It may be due to the fact that mites like most of the other taxa of soil arthropods are poorer in numbers in tropical than in temperate soils (Peterson and Luxton 1982). Their seasonal peaks of abundance occurred during winter and monsoon. Similar peaks of abundancy of Acarina in November in temperate soils were not unusual (Curre 1971). The dominance of Prostigmata, as recorded during the present study had been earlier reported by Loots and Ryke (1967) and Price (1973). Its seasonal abundance is relatively compared to that recorded in temperate woodlands. Besides, the density of Cryptostigmata was comparatively less than the range i.e., 20 X 10^2 to 50 X 10^2 m^2 recorded in temperate forest (Petersen and Luxton 1982). Its population abundance was low during the summer, as recorded in Mitchell (1977). The Mesostigmata were too few

in number to show any seasonal trend in their fluctuation (Usher 1971 Prlce 1973; Petersen and Luxton 1982).

The temperatures both at soil surface and at 5 cm depth, rainfall each being $P < 0.01$) were significantly negatively correlated with the abundance of total Acarina, (Petersen and Luxton 1982; Reddy 1984), the effect of moisture being indirect and to a large extent interwoven with that of temperature (Glasgow 1939). Prostigmata was significantly positively correlated with total iron ($P < 0.01$) whereas Cryptostigmata was negatively correlated with moisture and pH while positively correlated with total Fe_2O_3 being significant at 0.01 level. Mesostigmata was negatively correlated with temperature at 5 cm depth and organic carbon (both at $P < 0.05$) and P_2O_5 ($P < 0.01$) while positively correlated with pH ($P < 0.05$).

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